TA-73

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Date: July 18, 2002
Refer to: ER2002-0496

RECEIVED
JUL 2002
NMED Hazardous Waste Bureau

Mr. John Young, Corrective Action Project Leader
Permits Management Program
NMED – Hazardous Waste Bureau
2905 Rodeo Park Drive East
Building 1
Santa Fe, NM 87505-6303

SUBJECT: SUBMITTAL OF INTERIM MEASURES PLAN FOR POTENTIAL RELEASE SITE (PRS) 73-001(a) DEBRIS REMOVAL

Dear Mr. Young:

In accordance with the June 26, 2002 letter from James Bearzi, New Mexico Environment Department, to Dr. John Browne and Mr. Everett Trollinger, enclosed are two copies of the Interim Measures Plan for PRS 73-001(a) Debris Removal. This document was prepared by and for the Airport Landfill High Performing Team.

If you have any questions, please call Dave McInroy at (505) 667-0819 or David Gregory at (505) 667-5808.

Sincerely,

for
David McInroy, Acting Program Manager
Environmental Restoration Project
Los Alamos National Laboratory

Sincerely,

Everett Trollinger, Project Manager
Department of Energy
Office of Los Alamos Site Operations

DM/ET/NR/vn

Enclosure: Interim Measures Plan (ER2001-0472)

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ENVIRONMENTAL
RESTORATION
PROJECT

A Department of Energy
Environmental Cleanup Program

LA-UR-01-2923
July 2002
ER2001-0472

Interim Measure Plan for Potential Release Site 73-001(a) Debris Removal

Los Alamos
NATIONAL LABORATORY

Los Alamos NM 87545

CONTENTS

1.0 RATIONALE AND OBJECTIVE OF INTERIM MEASURE

1.1 Rationale for Proposed Interim Measure

The Los Alamos National Laboratory (the Laboratory) Environmental Restoration (ER) Project conducted a Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) (LANL 1998, 63070.1) at the former Los Alamos County Landfill [potential release site (PRS) 73-001(a)] starting in April 1994 and continuing on and off through September 1997. Site characterization sample data from this RFI indicated potential contamination in the Pueblo Canyon drainages downgradient of the landfill. This contamination, in addition to abundant surface debris in at least four of the drainages, is a result of past landfill operations. Removal of the surface debris followed by confirmatory and supplemental sampling, as required, will be completed as an interim measure (IM) to alleviate concerns about debris in a water course (NMED 1995, 54406.1) and the possibility of residual contamination that may remain at concentrations representing potential unacceptable risk to human or ecological receptors. In addition, these activities will help achieve the transfer of mesa-top airport property from US Department of Energy (DOE) to Los Alamos County ownership.

The chemicals of potential concern (COPCs) were identified for the drainages during the RFI. The locations containing the majority of the known debris have been identified as a result of several site visits. In general, the remedial options (section 3.0 of this document) are obvious, although there appears to be no single "best" option, and the time that it will take for actual debris removal has been estimated to be approximately 6 months. The current and future land-use assumption of continued use as an airport is straightforward and does not impact this IM or the subsequent site restoration.

1.2 Objective of Interim Measure

The primary objective of this IM is to remove surface debris from drainage ravines downgradient of the PRS 73-001(a) landfill. To achieve this objective, the ER Project has proposed actions that include further exploration for debris downgradient of the landfill; removal of surface debris in drainage ravines and in areas between drainage ravines; removal of contaminated soil, as necessary; collection of confirmatory samples following debris and soil removal; site restoration; and collection of supplemental samples, as required. A detailed scope of proposed activities is presented below.

- Review existing data and collect supplemental samples, as necessary, to define the extent of soil/sediment contamination associated with the PRS 73-001(a) drainages. A preliminary review of the data has been completed and it has been determined that supplemental sampling is not warranted prior to debris removal.
- Remove the surface debris from a minimum of four drainages that are currently known to contain debris and remove any surface debris encountered during the execution of this IM from areas between these drainages.
- Collect soil/sediment samples from any visibly stained areas during debris-removal activities.
- Collect confirmatory samples at representative locations following debris removal to (1) determine the presence or absence of contamination resulting from the debris; (2) define the extent of contamination, if present; (3) determine the need to remove any contaminated soil encountered; (4) and verify the adequacy of the cleanup.
- Complete site restoration activities, as necessary.

Debris removal within the main landfill, including the east end where debris is weathering out of the slope, is not currently included within the scope of this project. These areas will be remediated, as required, as part of a voluntary corrective measure (VCM) of the landfill.

Results of the IM will be detailed in an IM report to be prepared following completion of all field activities and receipt of all analytical data.

1.3 Cleanup Criteria

The following criteria were developed by the members of the Airport Landfill High Performing Team, concurred on by the NMED bureau chiefs affected, and proposed to the US Environmental Protection Agency (EPA) for this site. All agencies, state and federal, are now in agreement that meeting the following criteria within the identified areas will constitute the successful completion of this IM.

1. All refuse, including tires, wood debris, concrete, auto parts, and other metal scrap, in and around the several drainage channels should be removed, except those items that are substantially buried and therefore pose no reasonable potential to move. As a practical matter, items that are less than 50% buried in sediment should be removed. Items whose removal presents a real and credible threat to worker health and safety may also remain in place.

2. Appropriate best management practices (BMPs) should be installed where efficacious to limit or control the movement of disturbed soil and prevent other contaminants from migrating into surface water. All erosion control measures must be inspected and maintained on a regular basis to insure and assess their effectiveness.

3. At the base of the drainages containing refuse, one or more low-head retention structures (or equivalent) should be constructed to control and capture any pollutants that may migrate toward waters of the US. Such structures should be engineered to intercept stormwater runoff from low and moderate precipitation events.

4. If, storm events, up to and including the 2-year event, do not produce sufficient water at the point of retention for sample collection, it may be reasonably argued that no discharge from the drainages has occurred and that, therefore, no water sampling/analysis is required. In addition, water sampling and analysis may be necessary for only one landfill drainage if it can be demonstrated that other drainage outfalls are "substantially identical" (i.e., show similar significant sources of pollutants and stormwater discharge volumes; see 40 CFR 122.26 and Part 5.2.4 of the National Pollutant Discharge Elimination System [NPDES] Storm Water Multi-Sector General Permit [MSGP]). Finally, sampling and analysis must be performed in accordance with 40 CFR 136 and the MSGP.

5. Routine inspection and maintenance of the retention structure(s) is required to ensure that they are functioning as intended.

6. To prevent significant run-on, the landfill cap design for solid waste management units (SWMUs) 73-001(a,b,c,d) and 73-004(d) must include structural and/or nonstructural controls to divert stormwater away from the drainages.

7. In accordance with Part 4.0 of the MSGP and 40 CFR 122.26, it is the responsibility of the permittee to develop, maintain, and implement a site-specific Storm Water Pollution

Prevention Plan (SWPPP). All activities related to the landfill drainages, for example, should be documented in the site-specific SWPPP.

8. LANL will be required to comply with all other state and federal regulations.

2.0 SITE DESCRIPTION AND CHARACTERIZATION DATA

2.1 Site Type and Description

PRS 73-001(a) is an inactive municipal landfill in Technical Area 73 (TA-73) that is designated as a PRS and listed in Module VIII, Table A, of the Laboratory's Hazardous Waste Facility Permit (LANL 1990, 1585; 1994, 44146. This inactive landfill is located on DOE property at the Los Alamos County Airport, north of the asphalt taxiway to the hot pad and east of the asphalt aircraft tie down area (Figures 2.1-1 and 2.1-2). Several drainage pathways lead from the edge of the mesa adjacent to the landfill, down the side of Pueblo Canyon. The scope of this IM is limited to the drainages and other debris found on the Pueblo Canyon walls during the implementation of the IM.

The landfill consisted of a natural hanging valley that received municipal waste from the Laboratory and Los Alamos townsite for disposal. The north side of the landfill extended to and paralleled the edge of the mesa. To the east, the landfill extended to the end of the hanging valley and pinched out further east toward the hot pad (Figure 2.1-2). No documented historical releases are known to have occurred outside the landfill boundary. However, tires, car bodies, pieces of concrete and asphalt, empty drums, galvanized steel trash cans, and other miscellaneous debris are present in at least four drainage channels along the south slope of Pueblo Canyon adjacent to the landfill area. The largest volume of debris appears to be at the east end of the landfill in the drainage channel originating below the hanging valley (Figure 2.1-2, drainage D2). The D1 to D4 drainage channel designations were first used in the landfill RFI report (LANL 1998, 63070.1), and are used in this IM plan. An additional channel ("drainage C") originating approximately 600 ft west of drainage D2 and approximately 300 ft east of drainage D3 contains somewhat less debris. The remaining two drainage channels containing relatively large concentrations of debris are both located east of drainage D1. The first ("drainage B") originates approximately 100 ft east and appears to join drainage D1 approximately 400 ft downslope. The second ("drainage A") originates approximately 450 ft east of drainage D1. Drainages D1, D3, and D4 contain no accumulations of debris.

Operational History

In 1943, the DOE began operating the landfill. Garbage was collected twice a week from the Laboratory and townsite and burned on the edge of the hanging valley located north of the airport runway (Miller 1963, 00684). This intentional burning ceased in 1965, when Los Alamos County assumed operation of the landfill (Miller and Shaykin 1966, 36692). Heavy equipment was used to push the burned residues and ash into the landfill. The county continued to operate the landfill until June 30, 1973 (Drennon 1991, 00650). The landfill was subsequently closed. Debris in the drainages appears to have accumulated there incidentally as a result of landfill operations.

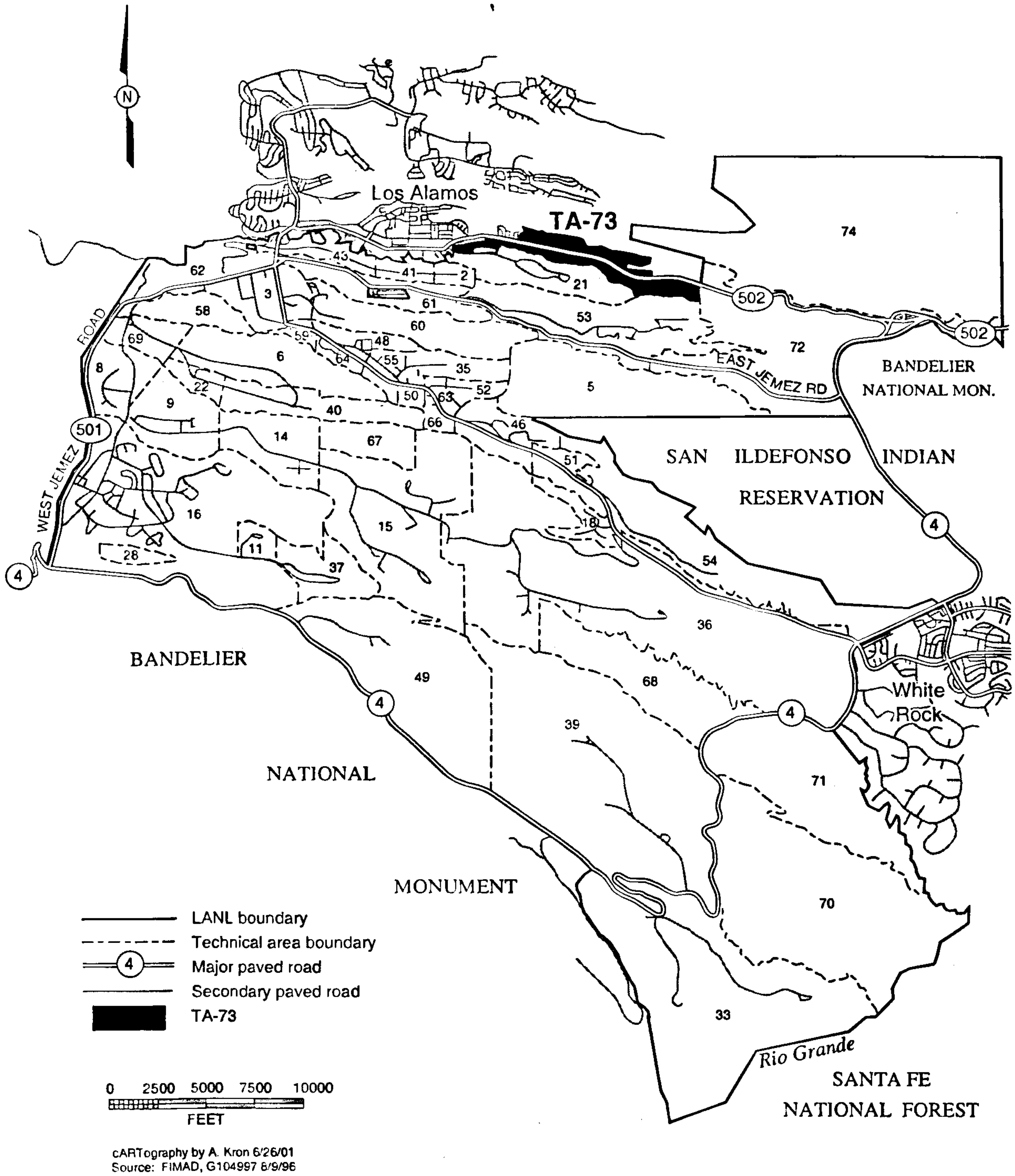

Figure 2.1-1. Location of TA-73 with respect to Laboratory TAs and surrounding landholdings

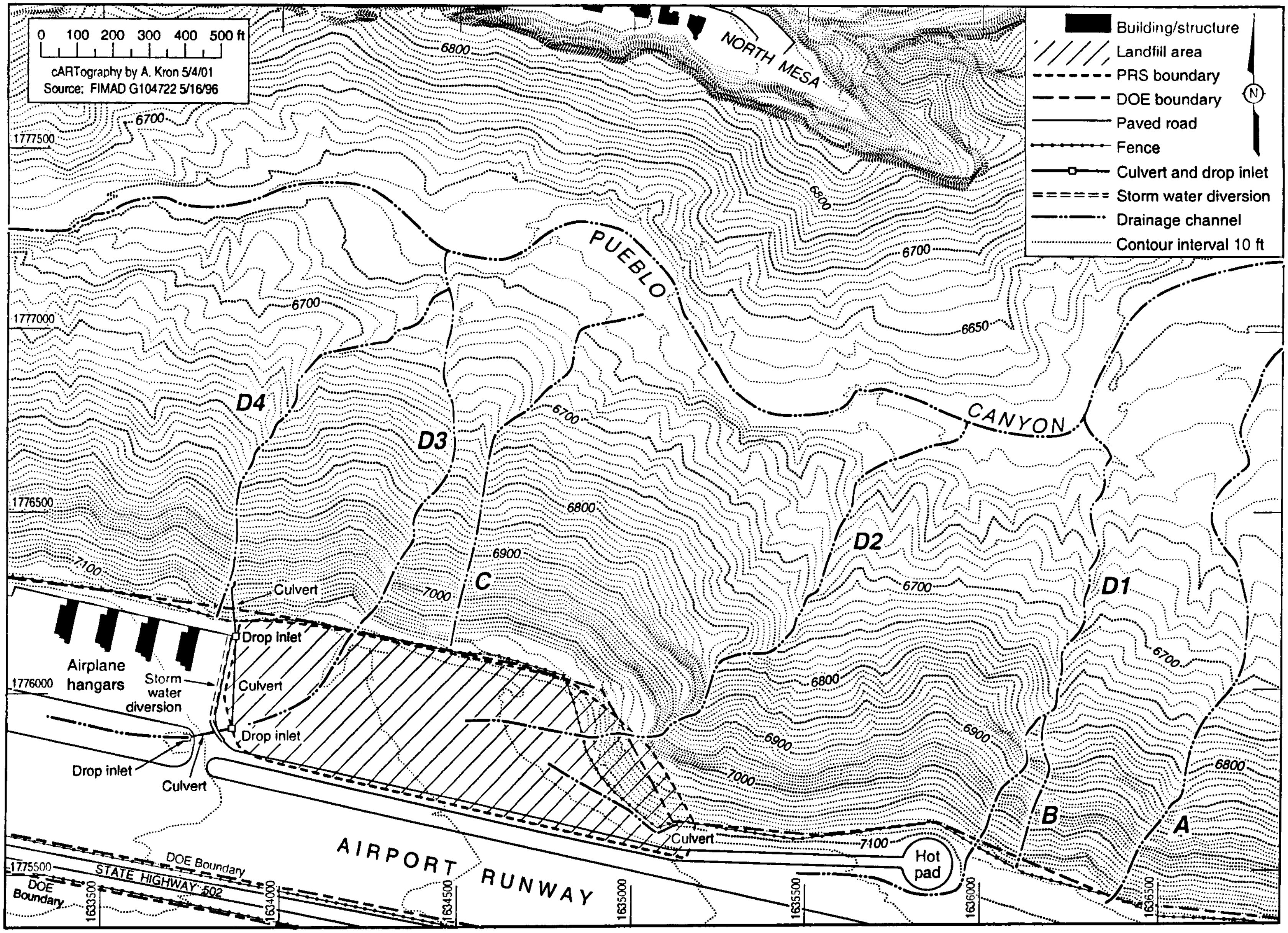

Figure 2.1-2. PRS 73-001(a) with primary drainage channels that originate on, or transect, the landfill surface

2.2 RFI Information and Other Decision Data

2.2.1 Previous RFI Investigations

Phase I RFI activities at the airport landfill began in April 1994 and continued intermittently through September 1997. The investigation was conducted in several phases that included three primary tasks: Task 1, Field Surveys; Task 2, Surface Sampling; and Task 3, Subsurface Sampling. As part of these tasks, several activities were completed, with geomorphic mapping and channel sediment sampling being the most relevant to the IM. During the geomorphic mapping, four primary drainages were identified that originated at or transected the surface of the landfill and extended to the canyon floor (Figure 2.1-2, drainages D1-D4). Three sediment accumulation areas were identified in each of these four drainages from which channel sediment samples were collected. Two sediment samples also were collected from a secondary drainage immediately west of drainage D2. A total of 15 sediment samples, including one quality assurance/quality control (QA/QC) duplicate, were collected from 13 locations. Table 2.2-1 summarizes the sample identification (ID) numbers, requested analytes and associated request numbers. The sample locations are depicted on Figure 2.2-1.

During preparation of the landfill RFI report, analytical data for the sediment samples were validated and reviewed to identify COPCs (LANL 1998, 63070.1). Table 2.2-2 lists the inorganic, radionuclide, and organic COPCs that were identified for sediment in the RFI report and gives the maximum detected concentration, the location, and depth for each. Figures 2.2-2, 2.2-3, and 2.2-4 show the locations where the COPCs were detected.

2.2.2 Screening Assessments

The sediment sample data are evaluated in the following sections (Section 2.2.2.1, Human Health, and Section 2.2.2.2, Ecological) to summarize the potential risk posed by the COPCs in the drainage channel sediment.

2.2.2.1 Human Health

The maximum concentrations of COPCs detected above background are presented in Table 2.2-3 (noncarcinogens), Table 2.2-4 (carcinogens), and Table 2.2-5 (radionuclides) and compared to their respective screening action levels (SALs). The SALs used in these comparisons are based on residential scenarios and are presented in the technical background document of soil screening levels (NMED 2000, 68554), the US Department of Energy's human health medium-specific screening levels (EPA 2000, 68410), and "Derivation and use of Radionuclide Screening Action Levels" (LANL 2001, 69683). The maximum concentrations by location for each COPC are shown on Figures 2.2-2, 2.2-3, and 2.2-4.

No noncarcinogens were detected above their SALs. The hazard quotients (HQs) (ratios of maximum concentrations to SALs) for each chemical were summed. The hazard index (HI) (total of HQs) was less than one< 1, indicating that no potential for increased human health hazard is expected from these chemicals at their maximum on-site concentrations.

Table 2.2-1
PRS 73-001(a) Channel Sediment Sample Summary

Location ID	Sample ID	Sample Type	Depth (ft)	Analyses Requested			
				SVOCs[a]	PCBs/ Pest.[b]	Inorganic Chemicals	Radionuclides
73-02151	0173-96-0101	Grab	0-0.67	1923	1923	1924	1925
73-02152	0173-96-0102	Grab	0-0.83	1923	1923	1924	1925
73-02153	0173-96-0103	Grab	0-0.67	1923	1923	1924	1925
73-02154	0173-96-0104	Grab	0-0.83	1923	1923	1924	1925
73-02154	0173-96-0105	Grab	0.83-1.67	1923	1923	1924	1925
73-02155	0173-96-0106	Grab	0-1.25	1923	1923	1924	1925
73-02156	0173-96-0107	Grab	0-0.83	1923	1923	1924	1925
73-02157	0173-96-0108	Grab	0.25-0.83	1923	1923	1924	1925
73-02158	0173-96-0109	Grab	0-0.83	1923	1923	1924	1925
73-02159	0173-96-0110	Grab	0-0.5	1923	1923	1924	1925
73-02160	0173-96-0111	Grab	0-0.5	1923	1923	1924	1925
73-02161	0173-96-0112	Grab	0-0.5	1923	1923	1924	1925
73-02162	0173-96-0113	Grab	0-1.0	1923	1923	1924	1925
73-02163	0173-96-0114	Grab	0-1.0	1923	1923	1924	1925
73-02163	0173-96-0118	Grab/ duplicate	0-1.0	1923	1923	1924	1925

[a] SVOCs = semivolatile organic compounds.
[b] PCBs/Pest. = polychlorinated biphenyls/pesticides.

The carcinogens were compared with their respective SALs. These SALs represent a one-in-a-million incremental risk of contracting cancer. The ratio of the maximum detected concentration of a carcinogen to its SAL quickly determines the incremental risk for exposure to the particular carcinogen. The total of all the ratios for all the carcinogens yields a total incremental risk for exposure to all the carcinogens simultaneously. The total of the ratios for all the carcinogens is 34, which corresponds to an incremental risk of 3.4×10^{-5}, or 3.4 in 100,000. Polyaromatic hydrocarbons account for 3.3×10^{-5} of the total risk. The New Mexico Environment Department (NMED) has indicated that a target risk of 1×10^{-5} is acceptable and the EPA range of acceptable risk is between 10^{-4} and 10^{-6}; therefore, no corrective action is required. Since the estimated carcinogenic risk of 3.4×10^{-5} is not significantly greater than the target risk, and because the contaminated sediment is of very limited extent and located on a relatively steep slope, the contamination in the drainages does not pose a potential unacceptable risk and supplemental sampling is not warranted at this time.

The one radionuclide detected above its fallout concentration, plutonium-239, was significantly less than its SAL. Using the ratio of the maximum concentration detected to SAL, which represents a dose of 15 mrem/yr, the maximum dose allowed by DOE-Albuquerque (AL) for releasing sites for unrestricted public use (DOE-AL 2000, 67153), the dose was calculated to be 0.06 mrem/yr. This is less than the 15-mrem/yr dose limit and therefore is acceptable.

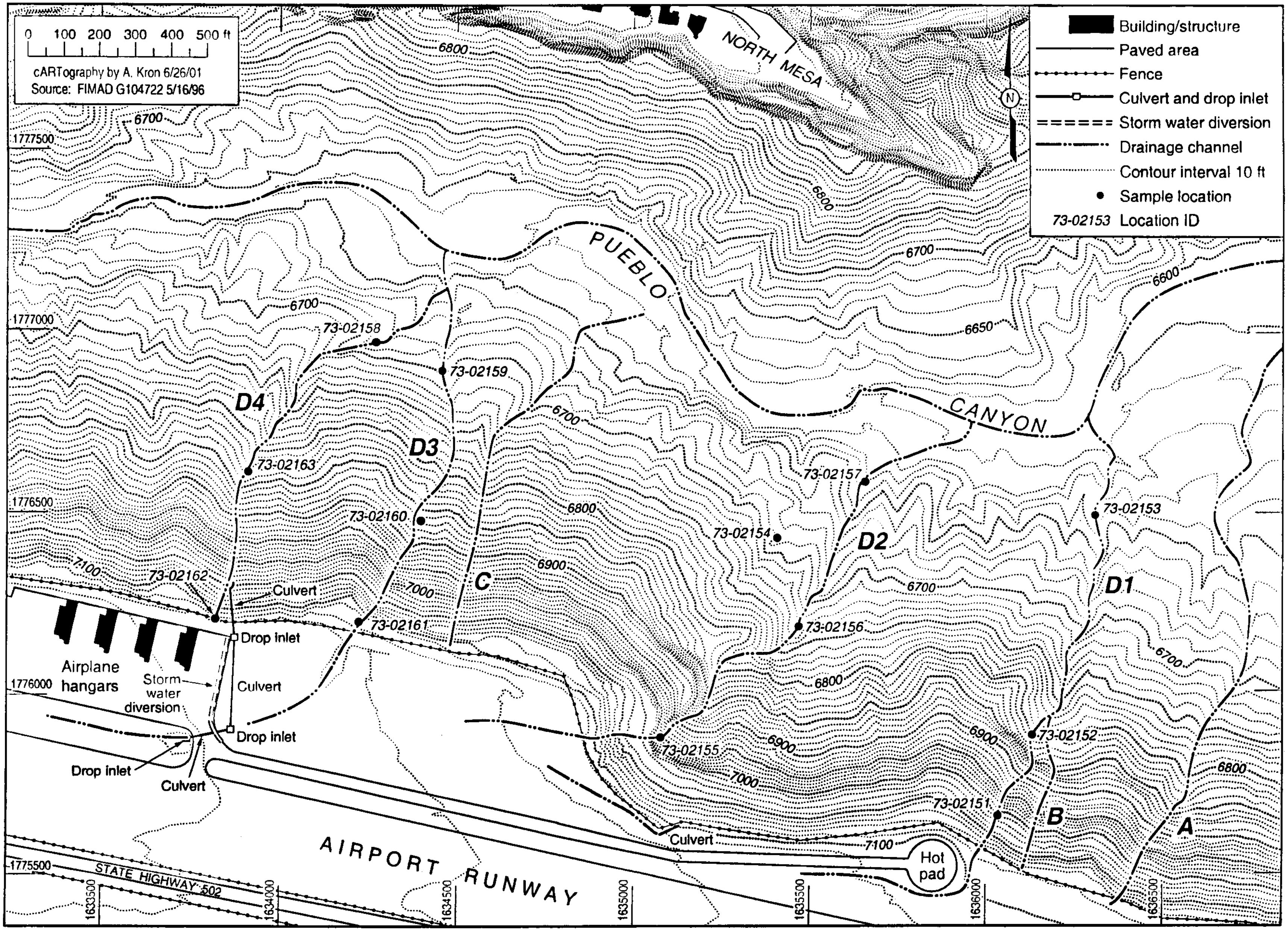

Figure 2.2-1. Channel sediment sampling locations

Table 2.2-2
PRS 73-001(a) Inorganic, Radionuclide, and Organic COPCs

Analyte	Location ID	Sample ID	Depth (ft)	Concentration[a]
Inorganics with concentrations at or above background values				
Beryllium	73-02161	0173-96-0112	0-0.5	1.9
Cadmium	73-02158	0173-96-0109	0-0.83	0.5
	73-02163	0173-96-0114	0-1	0.68
		0173-96-0118		0.63
Lead	73-02163	0173-96-0114	0-1	32.5
		0173-96-0118		48.4
Uranium, total	73-02163	0173-96-0114	0-1	8.1
Zinc	73-02156	0173-96-0107	0-0.83	53.7
	73-02161	0173-96-0112	0-0.5	56.3
	73-02163	0173-96-0114	0-1	234
		0173-96-0118		173
Radionuclides with concentrations at or above background/fallout values				
Cesium-137	73-02156	0173-96-0107	0-0.83	0.099(J)[b]
	73-02163	0173-96-0114	0-1	0.195
Plutonium-239	73-02151	0173-96-0101	0-0.67	0.052
	73-02153	0173-96-0103	0-0.67	0.027
	73-02156	0173-96-0107	0-0.83	0.043
	73-02158	0173-96-0109	0-0.83	0.171
	73-02162	0173-96-0113	0-1	0.0969
	73-02163	0173-96-0114	0-1	0.419
Detected organics				
Acenaphthene	73-02154	0173-96-0105	0.83-1.67	0.054(J)
	73-02156	0173-96-0107	0-0.83	0.043(J)
	73-02157	0173-96-0108	0.25-0.83	0.044(J)
	73-02158	0173-96-0109	0-0.83	0.64
Anthracene	73-02154	0173-96-0105	0.83-1.67	0.13(J)
	73-02155	0173-96-0106	0-1.25	0.035(J)
	73-02156	0173-96-0107	0-0.83	0.094(J)
	73-02157	0173-96-0108	0.25-0.83	0.089(J)
	73-02158	0173-96-0109	0-0.83	0.94
	73-02163	0173-96-0118	0-1	0.044(J)
Aroclor-1254	73-02163	0173-96-0114	0-1	0.12
		0173-96-0118	0-1	0.077

Table 2.2-2 (continued)

Analyte	Location ID	Sample ID	Depth (ft)	Concentration
Aroclor-1260	73-02151	0173-96-0101	0-0.67	0.055
	73-02155	0173-96-0106	0-1.25	0.089
Benzo(a)anthracene	73-02154	0173-96-0105	0.83-1.67	0.29(J)
	73-02155	0173-96-0106	0-1.25	0.094(J)
	73-02156	0173-96-0107	0-0.83	0.26(J)
	73-02157	0173-96-0108	0.25-0.83	0.3(J)
	73-02158	0173-96-0109	0-0.83	1.6
	73-02162	0173-96-0113	0-1	0.036(J)
	73-02163	0173-96-0114	0-1	0.081(J-)[c]
		0173-96-0118	0-1	0.11(J)
Benzo(a)pyrene	73-02154	0173-96-0105	0.83-1.67	0.34(J)
	73-02155	0173-96-0106	0-1.25	0.11(J)
	73-02156	0173-96-0107	0-0.83	0.31(J)
	73-02157	0173-96-0108	0.25-0.83	0.37
	73-02158	0173-96-0109	0-0.83	1.4
Benzo(b)fluoranthene	73-02154	0173-96-0105	0.83-1.67	0.25(J)
	73-02155	0173-96-0106	0-1.25	0.072(J)
	73-02156	0173-96-0107	0-0.83	0.23(J)
	73-02157	0173-96-0108	0.25-0.83	0.31(J)
	73-02158	0173-96-0109	0-0.83	1.4
	73-02163	0173-96-0114	0-1	0.095(J-)
Benzo(g,h,i)perylene	73-02154	0173-96-0105	0.83-1.67	0.23(J)
	73-02155	0173-96-0106	0-1.25	0.091(J)
	73-02156	0173-96-0107	0-0.83	0.26(J)
	73-02157	0173-96-0108	0.25-0.83	0.25(J)
	73-02158	0173-96-0109	0-0.83	0.92
Benzo(k)fluoranthene	73-02154	0173-96-0105	0.83-1.67	0.28(J)
	73-02155	0173-96-0106	0-1.25	0.089(J)
	73-02156	0173-96-0107	0-0.83	0.25(J)
	73-02157	0173-96-0108	0.25-0.83	0.28(J)
	73-02158	0173-96-0109	0-0.83	1.4
	73-02163	0173-96-0114	0-1	0.065(J-)
Bis(2-ethylhexyl) phthalate	73-02159	0173-96-0110	0-0.5	0.37(J)
	73-02163	0173-96-0118	0-1	0.04(J)
Chlordane (alpha-)	73-02163	0173-96-0114	0-1	0.0056
		0173-96-0118	0-1	0.0074

Table 2.2-2 (continued)

Analyte	Location ID	SampleID	Depth(ft)	Concentration
Chlordane (gamma-)	73-02158	0173-96-0109	0-0.83	0.0044
	73-02163	0173-96-0114	0-1	0.013
		0173-96-0118	0-1	0.015
Chrysene	73-02154	0173-96-0105	0.83-1.67	0.33(J)
	73-02155	0173-96-0106	0-1.25	0.11(J)
	73-02156	0173-96-0107	0-0.83	0.31(J)
	73-02157	0173-96-0108	0.25-0.83	0.34(J)
	73-02158	0173-96-0109	0-0.83	1.8
	73-02163	0173-96-0114	0-1	0.087(J-)
		0173-96-0118	0-1	0.11(J)
DDE [4,4-]	73-02157	0173-96-0108	0.25-0.83	0.0036
DDT [4,4-]	73-02155	0173-96-0106	0-1.25	0.0067
	73-02156	0173-96-0107	0-0.83	0.0093
	73-02157	0173-96-0108	0.25-0.83	0.019
	73-02158	0173-96-0109	0-0.83	0.038
	73-02162	0173-96-0113	0-1	0.0035
	73-02163	0173-96-0114	0-1	0.048
		0173-96-0118	0-1	0.057
Dibenz(a,h)anthracene	73-02154	0173-96-0105	0.83-1.67	0.072(J)
	73-02157	0173-96-0108	0.25-0.83	0.1(J)
	73-02158	0173-96-0109	0-0.83	0.24(J)
Dibenzofuran	73-02158	0173-96-0109	0-0.83	0.29(J)
Di-n-butylphthalate	73-02163	0173-96-0118	0-1	0.93
Fluoranthene	73-02154	0173-96-0104	0-0.83	0.043(J)
	73-02154	0173-96-0105	0.83-1.67	0.57
	73-02155	0173-96-0106	0-1.25	0.21(J)
	73-02156	0173-96-0107	0-0.83	0.57
	73-02157	0173-96-0108	0.25-0.83	0.58
	73-02158	0173-96-0109	0-0.83	3.8
	73-02162	0173-96-0113	0-1	0.05(J)
	73-02163	0173-96-0114	0-1	0.13(J-)
		0173-96-0118	0-1	0.18(J)
Fluorene	73-02154	0173-96-0105	0.83-1.67	0.065(J)
	73-02156	0173-96-0107	0-0.83	0.047(J)
	73-02158	0173-96-0109	0-0.83	0.52

Table 2.2-2 (continued)

Analyte	Location ID	Sample ID	Depth (ft)	Concentration[a]
Indeno(1,2,3-cd)pyrene	73-02154	0173-96-0105	0.83-1.67	0.21(J)
	73-02155	0173-96-0106	0-1.25	0.073(J)
	73-02156	0173-96-0107	0-0.83	0.21(J)
	73-02157	0173-96-0108	0.25-0.83	0.21(J)
	73-02158	0173-96-0109	0-0.83	0.85
Methylnaphthalene[2-}	73-02158	0173-96-0109	0-0.83	0.085(J)
Naphthalene	73-02158	0173-96-0109	0-0.83	0.43
Phenanthrene	73-02154	0173-96-0105	0.83-1.67	0.49
	73-02155	0173-96-0106	0-1.25	0.14(J)
	73-02156	0173-96-0107	0-0.83	0.38
	73-02157	0173-96-0108	0.25-0.83	0.35(J)
	73-02158	0173-96-0109	0-0.83	3
	73-02163	0173-96-0114	0-1	0.06(J)
		0173-96-0118	0-1	0.14(J)
Pyrene	73-02154	0173-96-0105	0.83-1.67	0.53
	73-02155	0173-96-0106	0-1.25	0.17(J)
	73-02156	0173-96-0107	0-0.83	0.46
	73-02157	0173-96-0108	0.25-0.83	0.56
	73-02158	0173-96-0109	0-0.83	2.7
	73-02162	0173-96-0113	0-1	0.06(J)
	73-02163	0173-96-0114	0-1	0.13(J-)
		0173-96-0118	0-1	0.27(J)

[a] Inorganic and organic chemical concentrations reported in milligrams/kilogram. Radionuclide concentrations reported in picocuries per gram.

[b] (J) = estimated value.

[c] (J-) = estimated value (biased low).

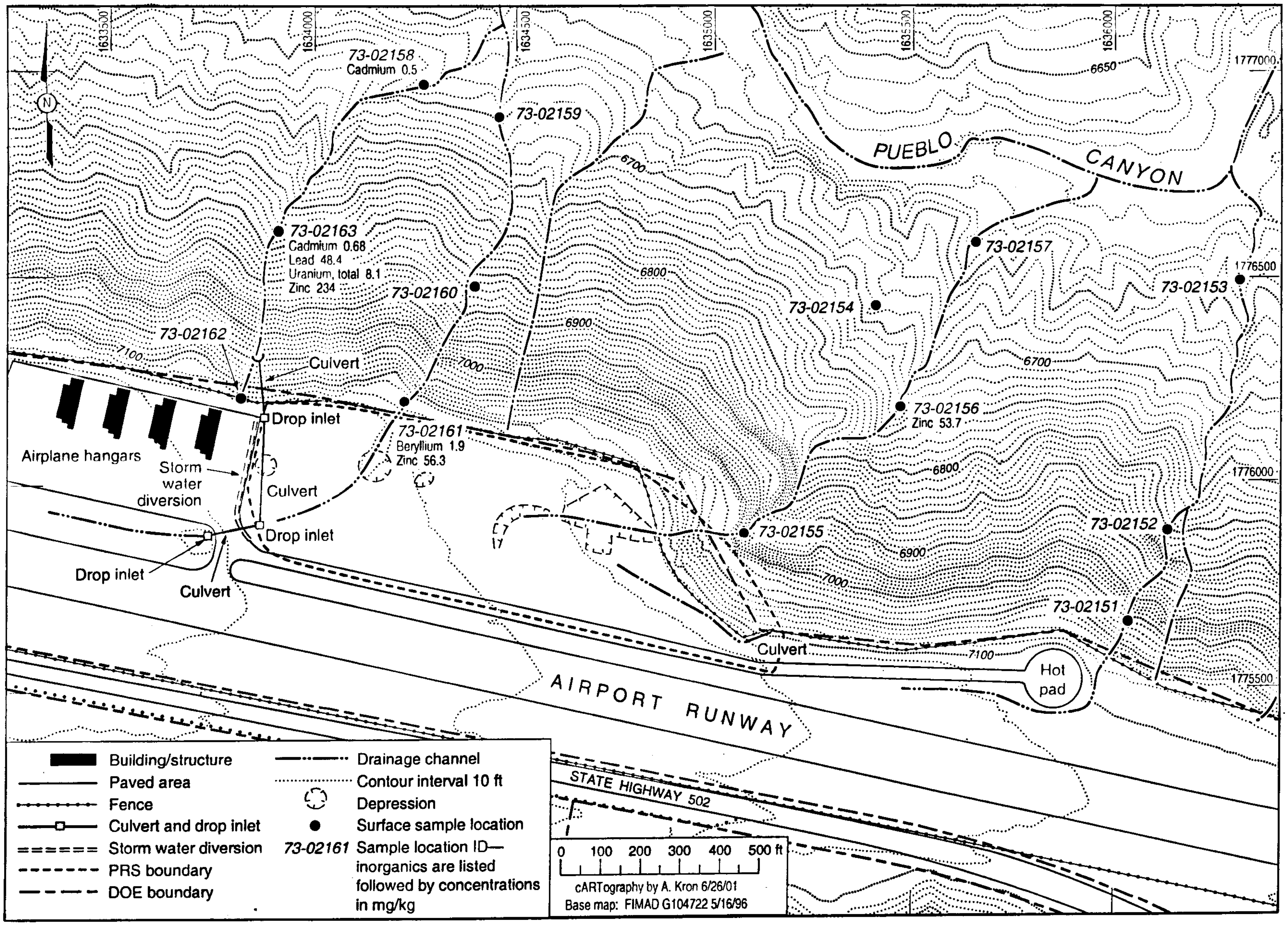

Figure 2.2-2. Inorganic COPCs in channel sediment samples with maximum concentrations shown by location

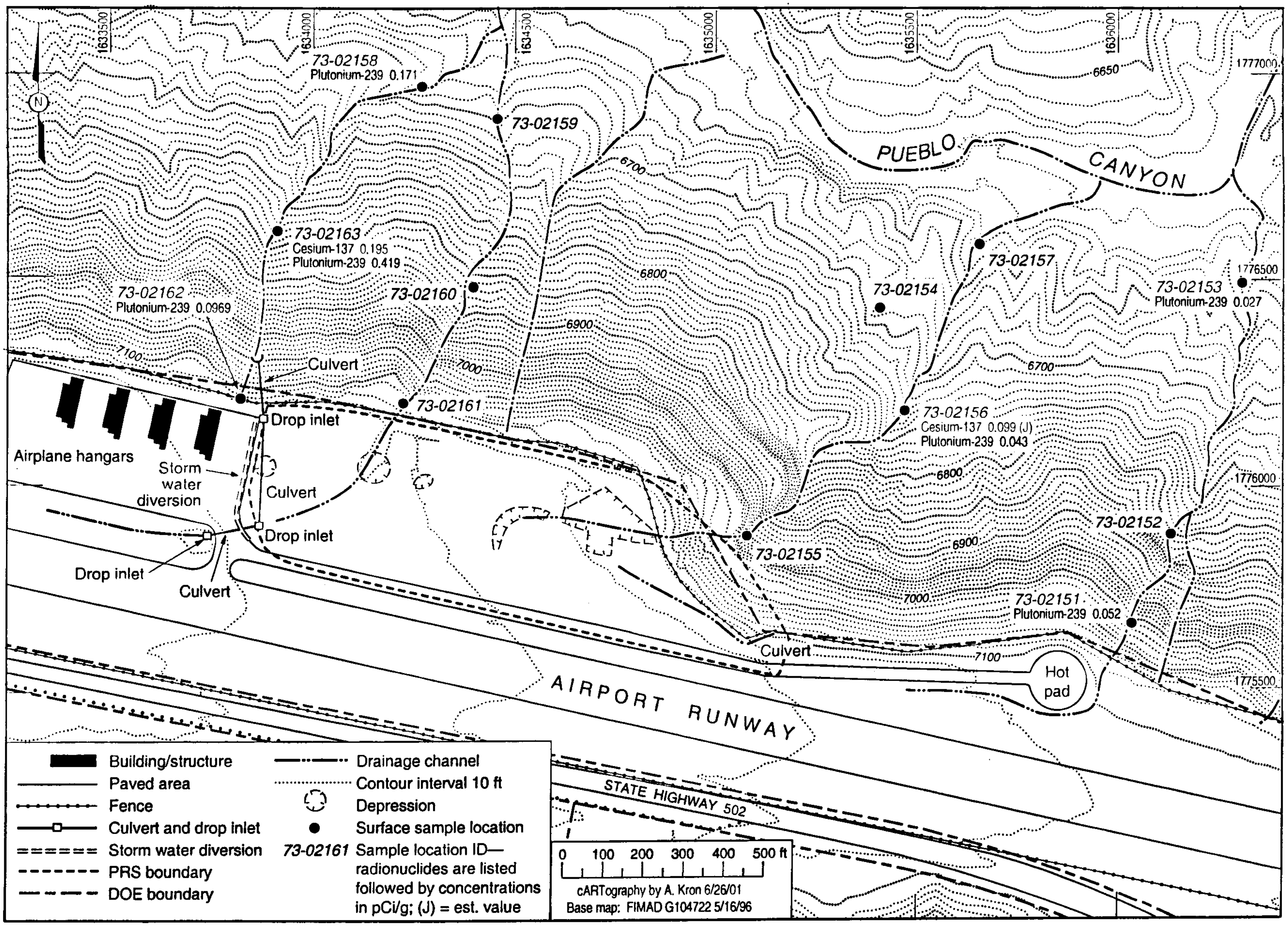

Figure 2.2-3. Radionuclide COPCs in channel sediment samples with maximum concentrations shown by location

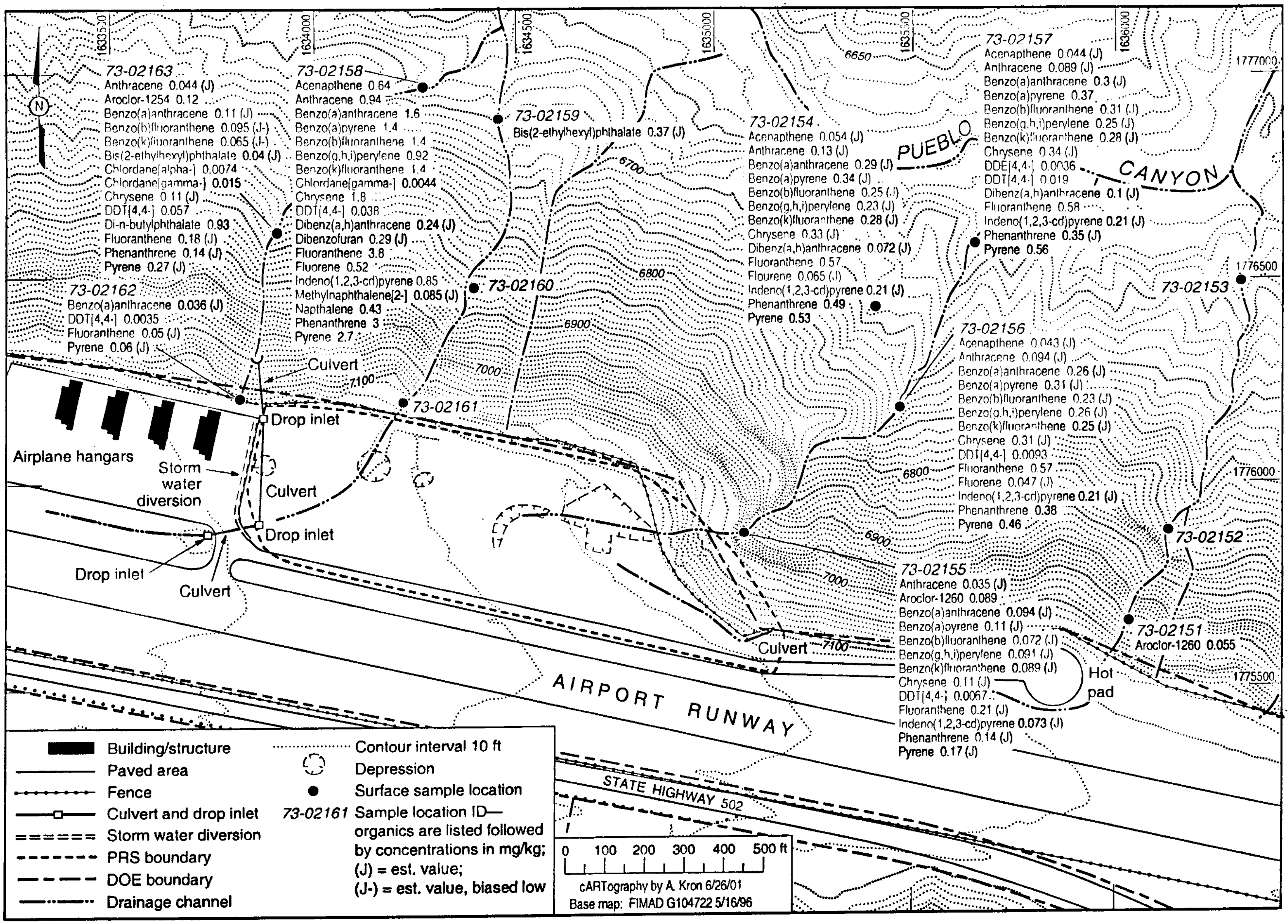

Figure 2.2-4. Detected organic compounds in channel sediment samples with maximum concentrations shown by location

Table 2.2-3
Noncarcinogenic COPCs Compared to SALs

COPC	Location ID	Maximum Concentration (mg/kg)	SAL (mg/kg)	HQ
Acenaphthene	73-02158	0.64	2800	0.0002
Anthracene	73-02158	0.94	22000	0.00004
Benzo(g,h,i)perylene[a]	73-02158	0.92	1800	0.0005
Cadmium	73-02163	0.68	70	0.01
Dibenzofuran	73-02163	0.29(J)	290	0.001
Di-n-butylphthalate	73-02163	0.93	6100	0.0002
Fluoranthene	73-02163	3.8	2300	0.002
Fluorene	73-02163	0.52	2100	0.0002
Lead	73-02163	48.4	400	0.1
Methylnaphthalene[2-][b]	73-02158	0.085(J)	53	0.002
Naphthalene	73-02158	0.43	53	0.008
Phenanthrene[c]	73-02158	3.0	1800	0.002
Pyrene	73-02158	2.7	1800	0.002
Uranium, total	73-02163	8.1	230	0.04
Zinc	73-02163	234	23000	0.01
			Total (HI)	0.2

[a] There is no SAL for benzo(g,h,i)perylene; therefore, the SAL for pyrene has been used as a surrogate, based on structural similarity.

[b] There is no SAL for 2-methylnaphthalene; therefore, the SAL for naphthalene has been used as a surrogate, based on structural similarity.

[c] There is no SAL for phenanthrene; therefore, the SAL for pyrene has been used as a surrogate, based on NMED technical document (NMED 2001, 68554).

2.2.2.2 Ecological

The maximum concentrations of COPCs are presented in Table 2.2-6 and compared to their respective minimum or final ecological screening levels (ESLs) (LANL 2000, RPF Record Package 186, version 2). This process evaluated eight terrestrial receptors representing several tropic levels. These receptors included

- generic plants,
- soil-dwelling invertebrates (represented by the earthworm),
- deer mouse (mammalian omnivore),
- vagrant shrew (mammalian insectivore),
- desert cottontail (mammalian herbivore),
- gray fox (mammalian carnivore),
- American robin (avian insectivore, avian omnivore, and avian herbivore), and

- American kestrel (avian invertebrate and flesh eater, a surrogate for threatened and endangered [T&E] avian species).

Since the debris slopes receive water only periodically during storm events and snowmelt, they do not support any aquatic communities. The rationale for these receptors is presented in "Screening Level Ecological Risk Assessment Methods" (LANL 1999, 64783).

Table 2.2-4
Carcinogenic COPCs Compared with SALs

COPC	Location ID	Maximum Concentration (mg/kg)	SAL (mg/kg)	Ratio of Maximum Concentration to SAL	Risk[a]
Aroclor-1254	73-02163	0.12	1.1	0.1	$1x10^{-7}$
Aroclor-1260	73-02155	0.089	0.22	0.4	$4x10^{-7}$
Benzo(a)anthracene	73-02158	1.6	0.62	2.6	$2.6x10^{-6}$
Benzo(a)pyrene	73-02158	1.4	0.062	22.6	$2.3x10^{-5}$
Benzo(b)fluoranthene	73-02158	1.4	0.62	2.3	$2.3x10^{-6}$
Benzo(k)fluoranthene	73-02158	1.4	6.2	0.2	$2x10^{-7}$
Bis(2-ethylhexyl)phthalate	73-02159	0.37(J)	35	0.01	$1x10^{-8}$
Chlordane (alpha-)	73-02163	0.0074	1.6	0.01	$1x10^{-8}$
Chlordane (gamma)	73-02163	0.015	1.6	0.01	$1x10^{-8}$
Chrysene	73-02158	1.8	61	0.03	$3x10^{-8}$
DDE (4,4')	73-02157	0.0036	1.7	0.002	$2x10^{-9}$
DDT (4,4')	73-02163	0.057	1.7	0.03	$3x10^{-8}$
Dibenz(a,h)anthracene	73-02158	0.24(J)	0.062	3.87	$3.9x10^{-6}$
Indeno(1,2,3-cd)pyrene	73-02158	0.85	0.62	1.37	$1.4x10^{-6}$
				Total incremental risk	$3.4x10^{-5}$

[a] Risk is calculated by dividing the ratio of the maximum concentration to the SAL by one million.

Table 2.2-5
Radionuclide COPCs Compared to SALs

COPC	Location ID	Maximum Concentration (pCi/g)	SAL (pCi/g)	Ratio of Maximum Concentration to SAL	Dose[a] (mrem/yr)
Plutonium-239	73-02163	0.419	110	0.004	0.06

[a] Dose is calculated by multiplying the ratio of the maximum concentration to the SAL by 15 mrem/yr.

The final ESL is compared to the maximum detected concentration in Table 2.2-6. An HQ was calculated for each chemical by dividing the maximum detected concentration by the final ESL. A HQ equal to or greater than 0.3 was used as a threshold to identify chemicals of potential ecological concern (COPECs) and determine which chemicals needed to be evaluated further (LANL 1999, 64783.1).

Table 2.2-6
Comparison of Maximum Concentrations with Final ESLs

COPC	Location ID	Maximum Concentration (mg/kg)	Final ESL	HQ Ratio of Maximum Concentration to Final ESL	Receptor	COPEC (yes/no)
Acenaphthene	73-02158	0.64	2.5	0.3	Generic plant	no
Anthracene	73-02158	0.94	2200	0.0004	Vagrant shrew	no
Aroclor-1254	**73-02163**	**0.12**	**0.12**	**1**	**Vagrant shrew (insectivore)**	**yes**
Aroclor-1260	**73-02155**	**0.089**	**0.05**	**1.78**	**American robin (insectivore)**	**yes**
Benzo(a)anthracene	**73-02158**	**1.6**	**3.3**	**0.5**	**Vagrant shrew (insectivore)**	**yes**
Benzo(a)pyrene	**73-02158**	**1.4**	**1.8**	**0.8**	**Vagrant shrew (insectivore)**	**yes**
Benzo(b)fluoranthene	73-02158	1.4	7.4	0.2	Vagrant shrew (insectivore)	no
Benzo(g,h,i)perylene	73-02158	0.92	12	0.1	Vagrant shrew (insectivore)	no
Benzo(k)fluoranthene	73-02158	1.4	13	0.1	Vagrant shrew (insectivore)	no
Bis(2-ethylhexyl) phthalate	**73-02159**	**0.37(J)**	**0.24**	**1.54**	**American kestrel (100% carnivore)**	**yes**
Cadmium	**73-02163**	**0.68**	**1**	**0.7**	**Generic plant**	**yes**
Chlordane (alpha)	73-02163	0.0074	2.1	0.003	American robin (insectivore)	no
Chlordane (gamma)	73-02163	0.015	2.1	0.007	American robin (insectivore)	no
Chrysene	**73-02158**	**1.8**	**3.3**	**0.5**	**Vagrant shrew (insectivore)**	**yes**
DDE (4,4')	**73-02157**	**0.0036**	**0.0018**	**2**	**American kestrel (100% carnivore)**	**yes**
DDT (4,4')	**73-02163**	**0.057**	**0.0028**	**20.357**	**American robin (insectivore)**	**yes**
Dibenz(a,h) anthracene	73-02158	0.24(J)	2.3	0.1	Vagrant shrew	no
Dibenzofuran	73-02163	0.29(J)	61	0.005	Generic plant	no
Di-n-butylphthalate	**73-02163**	**0.93**	**0.17**	**5.47**	**American robin (insectivore)**	**yes**
Fluoranthene	73-02163	3.8	26	0.1	Vagrant shrew	no
Fluorene	73-02163	0.52	29	0.02	Vagrant shrew	no
Indeno(1,2,3-cd) pyrene	73-02158	0.85	12	0.07	Vagrant shrew	no
Lead	**73-02163**	**48.4**	**76**	**0.6**	**American robin (herbivore)**	**yes**
Methynaphthalene[2-]	73-02158	0.085(J)	6	0.01	Vagrant shrew (insectivore)	no
Naphthalene	**73-02158**	**0.43**	**0.2**	**2.2**	**American robin (insectivore)**	**yes**
Phenanthrene	73-02158	3	110	0.03	Vagrant shrew (insectivore)	no
Plutonium-239	73-02163	0.419	18	0.02	Earthworm	no
Pyrene	73-02158	2.7	15	0.2	Vagrant shrew (insectivore)	no
Uranium, total	**73-02163**	**8.1**	**5**	**1.6**	**Generic plant**	**yes**
Zinc	**73-02163**	**234**	**10**	**23**	**Generic plant**	**yes**

Aroclor-1254; Aroclor-1260; benzo(a)anthracene; benzo(a)pyrene; bis(2-ethylhexyl)phthalate; cadmium, chrysene; 4,4'-DDE, 4,4'DDT; di-n-butylphthalate; lead; naphthalene; total uranium; and zinc all had HQs of 0.3 or greater and are bolded in Table 2.2-6.

The COPECs identified in Table 2.2-6 were further evaluated by calculating the HQs for each COPEC/receptor combination as well as the HIs for each receptor. The HQ for each COPEC for each receptor is calculated by dividing the ESL for each receptor by the maximum detected concentration for each COPEC. The HI is the sum of HQs for chemicals with common toxicological endpoints for a given receptor. The HI analysis provides a clearer picture of potential adverse impacts by determining how many receptors may be affected and provides information on T&E species. Table 2.2-7 presents a summary of the HI analysis for the debris slopes.

The HIs are less than 1.0 for the earthworm, the desert cottontail, and the red fox (Table 2.2-7). This indicates that the residual chemicals on the debris slopes are not present in concentrations considered harmful to the earthworm, desert cottontail, and red fox. HIs for the other receptors range from approximately 3 for the deer mouse to 33 for the insectivore robin, indicating the possibility of harm to these receptors. However, because these HIs assume extended or full time contact, and because of limited extent (i.e., contamination is limited to very narrow drainage channels), the amount of actual exposure each receptor would have to these chemicals would be limited due to their minimal contact time at a contaminated location. In addition, the vegetation currently growing in the drainages appears healthy with no obvious stress resulting from the presence of the COPECs in the sediment.

3.0 INTERIM MEASURE

In selection of the most effective method for removing debris from the drainage ravines, the following options are being considered:

- Manual removal—Hand-carry debris to a staging area where it would be loaded onto trucks for disposal. (Note: Some manual removal activities are common to all remedial options.)
- Crane—Use a crane to remove debris near the top of the mesa.
- Cable/pulley system—Construct a steel cable-and-pulley system to move debris from the slope to the staging area. Possible anchor points for the cable could be two bulldozers or a combination of a bulldozer and a tower/derrick.
- Helicopter—Use a helicopter to remove heavier debris and consolidated debris packages from remote locations with no other options for removal.
- Cable logging system (yarder)—Use a truck-mounted cable system manufactured specifically for logging operations in steep mountainous terrain.
- Road construction—Construct a road at least part of the way up the side of the mesa to facilitate debris removal from areas where the largest concentrations of debris are located.

The criteria used to evaluate each option included worker health and safety, environmental impact, approximate cost, load capacity, mobility, and availability. Appendix B describes the proposed options and the obvious advantages and disadvantages that should be considered when determining when and where each option can be used.

Table 2.2-7
Channel Sediment Samples Hazard Index Analysis for Debris Slopes

COPECs	Maximum Concentration (mg/kg)	HQ Plant	HQ Invertebrate (earthworm)	HQ Deer Mouse	HQ Vagrant Shrew	HQ Desert Cottontail	HQ Robin Insectivore	HQ Robin Omnivore	HQ Robin Herbivore	HQ Kestrel (intermediate carnivore)	HQ Kestrel (100% carnivore)	HQ Red Fox
Aroclor-1254	0.12	0.01	—	0.46	1	0.006	—	—	—	—	0.13	0.16
Aroclor-1260	0.089	—	—	0.59	—	0.007	1.78	0.9	0.07	0.468	0.45	0.24
Benzo(a) anthracene	1.6	0.1	—	0.2	0.5	0.004	—	—	—	—	—	0.04
Benzo(a)-pyrene	1.4	—	—	0.4	0.8	0.004	—	—	—		—	0.2
Bis(2-ethylhexyl) phthalate	0.37(J)	—	—	0.01	0.0128	5E-05	0.37	0.2	0.01	0.82	1.5	0.04
Cadmium	0.68	0.68	0.068	0.08	0.09	0.04	0.12	0.1	0.1	0.02	0.001	0.001
Chrysene	1.8	—	—	0.3	0.5	0.004	—	—	—		—	0.04
4,4'-DDE	0.0036	—	—	0.0001	0.0002	1E-06	1.6	0.8	0.06	1.2	2	0.0002
4,4'-DDT	0.057	—	—	0.02	0.04	0.0002	20.4	10.4	0.76	9.66	13.26	0.02
Di-n-butylphthalate	0.93	0.004	—	0.0004	0.001	2E-05	5.47	2.9	0.44	0.78	0.05	6.2E-06
Lead	48.4	0.1	0.02	0.1	0.2	0.09	0.5	0.55	0.6	0.04	0.02	0.01
Naphthalene	0.43	—	—	0.02	0.04		2.15	1.4	0.59	0.31	—	0.0001
Uranium	8.1	1.6	—	0.1	0. 3	0.006	0.4	0.21	0.04	0.05	0.003	0.002
Zinc	234	23.4	0.7	0.3	0.1	0.2	0. 3	0.7	1	0.04	0.03	0.01
HI	—	25.9	0.8	2.6	4.8	0.4	33	18	3.7	13.4	17.5	0.7

The option to be selected will meet or exceed cleanup criteria established by NMED and DOE and endorsed by EPA through correspondence dated October 3, 2001, and April 16, 2002, respectively. Most important, the option to be selected will accomplish the objective listed in the second bullet of section 1.2, while meeting the cleanup criteria listed in section 1.3 of this plan.

3.1 Site Restoration

Site restoration work will be completed on a drainage-by-drainage basis after the cleanup criteria have been satisfied, confirmatory samples have been collected, sample results have been reviewed, and a determination made that no soil removal or additional sampling are required. Site restoration may consist of several tasks. Disturbed areas will be raked and recontoured, as required. Jute matting, straw bales, and/or straw wattles may be installed to prevent erosion. Mulching and reseeding with approved mixtures of seed may be done in any disturbed area that could be stabilized by vegetation. Additionally, detention structures will be constructed at the foot of each drainage to prevent future runoff from entering the Pueblo Canyon stream channel.

4.0 SAMPLING ACTIVITIES

4.1 Supplemental Sampling

Based on a review of the existing chemical data for the sediment within the four primary drainages sampled during the RFI, it was determined that supplemental sediment sampling was not necessary prior to debris removal. However, for health and safety and waste characterization purposes, a preliminary site walkover with hand-held radiation meters will be done to screen debris and surrounding soil for radioactive contamination before debris removal begins. For waste management purposes only, a percentage of the removed debris will be swiped and counted to confirm that no radioactive contamination exists.

During debris removal, if an unknown material, sludge or liquid, is encountered in any kind of a container, samples of this material will be collected and analyzed per the waste characterization strategy form (WCSF).

4.2 Confirmatory Sampling

Following debris removal, confirmatory soil samples will be collected to verify that no contaminants were spilled or leached from the debris. Confirmatory samples will be collected at no more than 15 locations per drainage; however, the actual number and distribution of these sample locations will be determined following debris removal. In general, if there is no visible evidence of contamination beneath removed debris, confirmatory samples will be collected at approximately 30-ft intervals. As a standard practice, confirmatory samples will also be collected of any stained soil beneath removed debris. The samples will consist of surface soil or sediment grab samples collected using the spade-and-scoop technique (LANL-ER-SOP 6.09, Spade and Scoop Method for the Collection of Soil Samples). If the soil or sediment at any sampling location is greater than2 ft thick, a second sample will be collected approximately 2 ft below the first. The samples will be analyzed for an analytical suite consisting of total analyte list (TAL) metals (inorganic chemicals), semivolatile organic compounds (SVOCs), perclorate, pesticides/polychlorinated byphenyls (PCBs), and selected radionuclides (plutonium-239, cesium-137, and strontium-90). The samples will be handled pursuant to all pertinent ER Project standard operating procedures (SOPs).

Following data validation, the confirmatory sample data will be reviewed and assessed to determine if releases occurred as a result of the debris in the drainages and to confirm that the extent of contamination, if present, has been adequately defined. A decision then will be made by the Townsites Teamleader in consultation with the High Performing Team regarding the necessity for possible sediment/soil removal to remediate contamination, or to collect additional samples to better define the extent of contamination. If sediment/soil removal is required, cleanup criteria and remediation techniques will be developed at that time, based on the nature and extent of contamination being removed.

5.0 MAINTENANCE AND INSPECTION

Site restoration work, including any stormwater BMPs, will be inspected and approved by the Laboratory's Water Quality and Hydrology Group (RRES-WQH), as required, following installation. Site restoration work will be performed in accordance with an approved SWPPP.

6.0 WASTE MANAGEMENT

6.1 Estimated Types and Volumes of Waste

Based on preliminary site reconnaissance visits, most of the surface debris appears to consist of tires and scrap metal. The scrap metal will include empty drums, car bodies, galvanized steel trash cans, engine blocks, washing machines, and other miscellaneous items. Some wood and glass debris will consist primarily of large cable spools and ceramic dinnerware, respectively. The volume of these wastes is difficult to estimate. For the sake of planning, it has been assumed that there will be a total of approximately 600 yd^3 of debris.

6.2 Method of Management and Disposal

The debris will all be moved to a staging area where it can be segregated into recyclables and disposables. All tires will be transported to the tire recycling area at the Los Alamos County Landfill. Scrap metal that can be recycled will first be compacted, if possible, using a backhoe or other piece of heavy equipment. The recyclable metal will then be transported to a recycling facility in Espanola. Disposable debris will be profiled and disposed of at the Los Alamos County Landfill. All waste management and disposal will be conducted pursuant to the WCSF.

Even though much of the debris will be screened with hand-held radiation meters before field activities begin, a certain percentage (as defined by HSR-1) of the debris will be swiped and counted by the Laboratory's Health Physics Operations Group (HSR-1) before being released for recycling or disposal.

If unidentifiable sludges or liquids are encountered in any drums or other containers, they will be sampled and analyzed by the Laboratory's Solid Waste Regulatory Compliance Group (RRES-SWRC) prior to disposal pursuant to the WCSF.

7.0 PROPOSED SCHEDULE AND UNCERTAINTIES

7.1 Proposed Schedule of Activities

Table 7.1-1 presents an approximate schedule of activities. Currently, the many uncertainties regarding the planning of the overall task make it impossible to provide a detailed schedule with start and end dates for the various subtasks. Therefore, the schedule has been expressed in approximate activity duration. Even activity duration can be significantly impacted by changes in scope or in the details of how a subtask is completed.

Table 7.1-1
Approximate Schedule of Activities

Subtask	Activity Duration (days)
IM plan preparation	60
Readiness review	60
Field preparation/mobilization	10
Site remediation and sampling	120
Sample analyses	45
Site restoration	10
IM report preparation	30

7.2 Uncertainties

Numerous uncertainties may affect the approximate schedule of activities, some of which are discussed below:

- Debris volume. To date, four drainages have been identified that contain concentrations of debris that will require removal. If additional drainages are discovered that contain debris, the level of effort required for debris removal will increase accordingly. The volume of debris in the four drainages is largely unknown. However, for the purposes of cost estimating and scheduling, a total of 600 yd^3 of debris has been assumed (150 yd^3 per drainage). Although this is thought to be a conservative estimate, the actual volume of debris could be significantly higher, thereby increasing the removal time.
- Worker capability. Most of the debris will be picked up manually, moved to a central gathering location, and placed into a cargo net, bag, or other approved container. Lifting straps or cables will be used to secure other debris such as tires for removal. Each work crew is assumed to achieve and maintain a specific productivity level for the duration of the field activities; e.g., fill 1-yd^3 container per hour. However, if this assumption is incorrect, a significant schedule deviation could occur.
- Ease of removal. Debris may be much more difficult to move into staging areas than is expected.
- Helicopter capability. Certain assumptions also were made regarding the productivity of the helicopter. It was assumed that, on average, the helicopter could complete a round trip, from one pickup to the next, in approximately 10 min, and that a minimum of 1 yd^3 of debris could be transported each trip. If the time for a round trip is more than anticipated, helicopter costs could increase dramatically and the schedule would be adversely impacted.
- Cable/pulley system capability. The time and cost necessary to design, construct, and implement a cable/pulley system represent a best guess based on conjecture and assumptions that may prove too optimistic. Estimating the productivity of a cable/pulley system requires even more conjecture, making it difficult to compare the cost-effectiveness of such a system to that of the

helicopter. Any problems or delays during design or construction would impact schedule and actual productivity may be much less than assumed.

Other factors that could adversely impact the project duration are (1) decisions to use mostly manual labor as opposed to mechanized removal options; (2) inclement weather, particularly freezing weather and snow if the project is delayed into the winter months; (3) the discovery of chemical contamination which could, in turn, result in delays while determining risk to workers, performing additional worker health and safety training, and/or additional waste management; (4) fire restrictions that preclude working or limit the types of tasks that can be accomplished; and (5) equipment availability.

8.0 REFERENCES

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Appendix A

Acronyms and Abbreviations

BMP	best management practice
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
DOE	US Department of Energy
EPA	US Environmental Protection Agency
ER	environmental restoration
ESL	ecological screening level
HI	hazard index
HQ	hazard quotient
HSWA	Hazardous and Solid Waste Amendments of 1984
IM	interim measure
MGSP	NPDES Storm Water Multi-Sector General Permit
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
PCB	polychlorinated biphenyl
PRS	potential release site
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
SAL	screening action level
SOP	standard operating procedure
SVOC	semivolatile organic compound
SWPPP	Storm Water Pollution Prevention Plan
T&E	threatened and endangered
TA	technical area
TAL	target analyte list
VCM	voluntary corrective measure
WCSF	waste characterization strategy form

Appendix B

Interim Measure Options

The primary objective of this IM is to remove surface debris from the drainage ravines and intervening areas downgradient of PRS 73-001(a). Of the six options considered for debris removal, four (manual removal, crane, cable/pulley system, and helicopter) are presented for further evaluation. The remaining two options were eliminated from further consideration for the reasons described below. Field activities within each drainage generally involve a combination of two or more of these options. Because the actual capability and effectiveness of the four selected options will be somewhat unknown until fieldwork begins, the final form and design of the debris recovery effort in each drainage probably will evolve as the field effort progresses. Each option will be continually evaluated under actual field conditions, and design or procedural changes may be made frequently to increase safety or debris removal efficiency.

The option of building a road up the side of the mesa was eliminated from further consideration because of the extreme amount of environmental damage that would occur during construction and because of the hazards inherent in operating heavy machinery on a steep slope. However, the possibility of driving a bulldozer partway up the slope for use as an anchor point may still be considered. The option of using a cable logging system has also been eliminated, at least temporarily, because of the lack of availability of such a system in New Mexico. A cable logging system would have to be purchased and mobilized from the west coast or Canada, and the total price would be comparatively high.

Debris removal first would require using hand-held tools such as shovels, picks and pry bars, and manual or power-activated winches to loosen the tires and other debris from the surrounding sediment. Any sediment adhering to the debris will then be removed. In addition, large pieces of debris-such as car bodies may be cut into smaller pieces to facilitate removal. These activities will be required prior to debris removal by any of the mechanical removal options.

General discussions of the four options selected as the most capable of achieving the primary objective are presented below.

Manual Removal

A totally manual removal would involve hand carrying, rolling, or dragging as much of the debris as possible to the existing road at the bottom of the canyon where it could be staged and loaded onto trucks. This would be practical only for smaller and lighter debris, and for debris that is already close to the bottom of the canyon. As distance from the road increases, this method of removal would become less efficient and more hazardous for the workmen. However, mechanical aides such as lightweight winches could possibly be set up at strategic positions to assist the workmen, thereby increasing the distance from which debris could be efficiently moved by hand. Besides size and weight of the debris, and distance from the bottom of the canyon, another limiting factor for manual removal is the steepness/ruggedness of the terrain over which the debris must be moved. If a road were constructed, manual removal could even be a viable option for debris closer to the mesa top; however, due to the environmental damage, Threatened and Endangered Species considerations, and road worker safety concerns, installing a road up the side of the canyon will require additional, detailed evaluation.

Extensive handling of the debris will be a component of any debris-removal scenario. Debris that is already near the bottom of the canyon and any other debris that could be efficiently and safely moved by hand, as determined by the field team leader and site safety officer, may be manually moved to the existing road at the canyon bottom regardless of the method used to remove the remainder of the debris.

Advantages

- Worker health and safety. As long as the pathways for carrying debris are kept relatively short and unobstructed, the health and safety risk of significant injury should be low. However, as distances and slope angles increase, and the terrain becomes more irregular, health and safety concerns will increase, thereby making the health and safety aspects of manual removal a disadvantage.

- Environment. Manual removal would cause the least amount of disturbance to the environment. However, continually carrying or dragging debris over the same pathway eventually could create environmental damage that would require the installation of more extensive stormwater BMPs and restoration.

- Cost. Over the short term, or for very limited scope, manual removal would be the least expensive option.

Disadvantages

- Load capacity. Workmen would be restricted to relatively light loads (<50 LB) that could be hand-carried or easily moved with the assistance of lightweight winches.

- Mobility. Workmen would be restricted to moving debris that is already near the bottom of Pueblo Canyon and that is located in terrain that is not too irregular to safely traverse while carrying a load.

- Remote access. The laborers would be restricted to moving debris that is already near the staging area and that is located in relatively easy-to-access areas.

- Cost. Due to the extent, volume, and nature of the debris the total duration of the project, and therefore the cost of the project would ultimately be greater under this scenario.

Crane

The use of a crane would be restricted to removing debris that is very close to the mesa top. If the use of a crane were thought to be an effective removal option in a particular situation, the type, size, and lifting capacity of the crane would be evaluated with respect to the type, location, and weight of the debris and the availability of adequate safe lifting sites in which to stage the crane.

Removal by crane would require that the debris first be loaded into cargo nets, fabric waste bags, or some alternative container. Lifting straps could also be used to lift certain types of larger debris. The crane's lifting cable would then be attached to the container or strap and the debris would be lifted to the top of the mesa. However, at some point, as the lateral distance from the crane and the distance down the slope increase, the crane would be unable to continue safely and other removal options would need to be instituted.

Advantages

- Worker health and safety. Using a crane is a standard operation with well-defined capabilities and safety guidelines. Because the hazards are well understood, they can be planned for and mitigated, thereby creating minimal health and safety risks for the workmen.

- Environment. As long as the loads are lifted straight up, disturbance to the environment will be minimal. If loads must be dragged along the ground until they can be lifted vertically, some vegetation may be damaged, although measures could be taken to minimize this damage. However, because of safety considerations, the use of a crane to drag loads across the ground for any appreciable distance would not be permitted.

- Load capacity. The load capacity of a crane would be at least as high or higher than the load capacity for any other option being considered.

Disadvantages

- Cost. Crane rental, depending on size and capacity, can be very expensive. However, under appropriate circumstances and for short periods of time, a crane may be a cost-effective method of debris removal.

- Mobility. A crane would be mobile only in its ability to be moved to almost any location along the rim of the mesa at which it could be safely staged. However, any movement and setup of the crane would require some potentially expensive bulldozer and site preparation work along the edge of the mesa top to provide adequate access roads and setup pads. In spite of its mobility, the use of a crane to recover debris beyond the uppermost portion of the slope would be very limited. The laborers would be restricted to moving debris that is already near the staging area and that is located in relatively easy-to-access areas.

- Remote access. Access would be limited to debris that is very near the top of the mesa.

Cable/Pulley System

A cable/pulley system is considered a viable option for moving large volumes of debris, relatively quickly, from any position on the slope above which the system can be constructed. This system would be mobile, would allow lifting loads of up to 1000 LB, and would have the flexibility to move loads either up- or downslope to a staging area.

The cable/pulley system would have the following design elements: (1) a primary overhead steel cable that would be installed from the bottom of the canyon to the top edge of the mesa, (2) a secondary steel cable that would pull the load either up or down the primary cable, and (3) a winch line that would lift and support the load while it is moved to the staging area. The primary steel cable would most likely consist of approximately 1500 ft of 3/4 in.-diameter wire-wrapped steel cable. This cable would be stretched between a bulldozer at the top of the mesa an anchor at the bottom of the canyon. The secondary steel cable would consist of a similar length of smaller-diameter, wire-wrapped steel cable that would pull the load up or down the primary cable. A battery-operated winch-and-pulley system would lift and support the load while it is moved to the staging area.

Advantages

- Cost. The initial cost to design and construct a cable/pulley system would be relatively high, but once constructed, the cost of maintaining and operating the system would be relatively low. The cost-effectiveness of such a system ultimately would depend on its productivity and on the length of time that the system could be used, thereby decreasing the amount of time that manual or helicopter removal would be required.

- Load capacity. The cable/pulley system would be designed to safely lift and move loads of up to 1000 lb. This lifting capacity would be adequate for most loads the system would be expected to move.

- Mobility. The cable/pulley system would be somewhat mobile since the bulldozer used for the top anchor could be moved along the rim of the mesa. The system's mobility would be most severely limited by the tall ponderosa pines and fir trees that are fairly abundant on the south side of Pueblo Canyon. Considerable cost also would be associated with moving and rerigging the system, thereby making it advantageous to move the system as little as possible.

Disadvantages

- Worker health and safety. Constructing and operating this system would present unique health and safety hazards that must be defined and mitigated. Initial impressions of the health and safety aspects of such a system are that it would potentially be the most hazardous of the removal options.
- Environment. To allow construction or increase mobility of the primary cable, it may be necessary to cut down an occasional pine or fir tree. Movement of the bulldozer and construction of a stationary anchor at the bottom of the canyon also would cause some of disturbance to the environment.
- Remote access. Access would be limited to debris within a given distance on either side of the primary cable. The primary cable would be somewhat moveable, but it would not be cost-effective to move the cable for only a few pieces of debris.
- Mobility. The laborers would be restricted to moving debris that is already near the staging area and that is located in relatively easy-to-access areas.

Helicopter

For heavy debris, and debris for which no other removal option is available, a helicopter could be used to lift the debris out of the canyon to a staging area. If use of the helicopter is determined to be safe and relatively cost-effective, it also may be used for removing smaller debris. The use of a helicopter is relatively simple in that it does not require a great deal of up-front planning and design. The helicopter company being considered for this project has extensive experience with recovery and rescue jobs. Use of a helicopter primarily will present logistical and health and safety issues that must be addressed.

Debris removal by helicopter would require that the debris first be loaded into cargo nets, fabric waste bags, or some alternative container. Lifting straps could also be used to lift tires and certain types of larger debris. If there are tall trees in the immediate vicinity, the debris may need to be pulled some distance away from the trees in order for the helicopter to safely approach and lower its lifting cable.

Advantages

- Environment. Use of a helicopter would cause relatively little environmental damage compared to the other options.
- Load capacity: The helicopter would be useful for loads of up to 1000 LB, which would equal the design capacity of the cable/pulley system. Only a crane would have a higher lift capacity.
- Mobility. A helicopter essentially could reach any location on the side of the canyon. It would be limited only by the proximity of very tall trees and vertical tuff outcrops.

- Remote access. Since a helicopter could access most locations on the side of the canyon, it would be useful for recovering isolated debris in areas that are too remote to set up the cable/pulley system or to remove manually.

Disadvantages

- Worker health and safety. The use of a helicopter will present some health and safety issues since an accident could be potentially catastrophic. However, since helicopters have been used for similar activities for decades, these issues are well defined and understood. The various issues will be addressed, either in the site-specific health and safety plan or the aviation safety plan. Other potential issues may involve excessive noise complaints from residents on North Mesa and air traffic control problems with incoming or outgoing air traffic at the airport. However, the airport manager has indicated that coordinating the helicopter and other airport traffic would not be a problem. An advantage of using the helicopter is that it would minimize the amount of time the workmen would spend moving up and down the slope, thereby decreasing their exposure to potential falls and other related accidents.

- Cost. The hourly rental rate for a helicopter is relatively expensive. Because hourly costs continue to accrue when the helicopter is on-site, the cost-effectiveness of this option depends entirely on how much debris is moved per hour, and how many total hours are needed to complete the work.